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AUTHOR(S):

MACHIZUKA, AKIRA; TSUNEKAWA, KENGO;
FURUKAWA, HIROSHI; KUMADA, KAORU

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Some physiological findings on sensation of the parietal peritoneum

by

AKIRA MACHIZUKA, KENGÔ TSUNEKAWA, HIROSHI FURUKAWA
and KAORU KUMADA

From the 2nd Surgical Division, Kyoto University, Medical School
(Director : Prof. Dr. CHUJI KIMURA)

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Parietal peritoneal sensation is said to have different nature from that of the visceral peritoneum and not to play a role in producing visceral-pain.

Our investigations on abdominal pain had created a necessity for some knowledges of parietal peritoneum which promoted the observation of parietal peritoneal sensation. And the observation found some additional but interesting informations of parietal peritoneum.

Above all, in this report we will describe a fact that some parital peritoneal nerve has the viseral sensory nature.

Experimental Methods

1) Adult cats were anesthetized with nembutal and laid on the right side. The right abdominal wall was opened with a pararectal incision and the left wall of the wound was elevated with some sutures in order to apply the stimulants on the peritoneal surface.

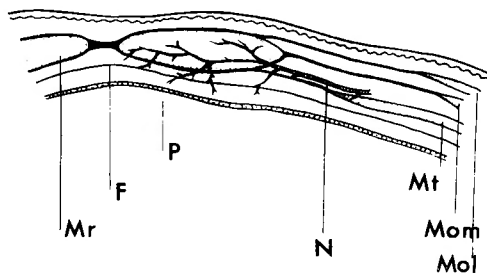


Fig. 1. Schematic representation of innervation in the front side of the parietal peritoneum

Mr : Musculus rectus abdominis

Mom : Musculus obliquus abdominis interna

Mol : Musculus obliquus abdominis externa

Mt : Musculus transversus abdominis

F : Fascia transversalis

P : Peritoneal epithelium

N : A branch of the intercostal nerve through the M. transversus abdominis

The intercostal nerve branches which are found in the layer of M. transversus abdominis penetrate the transversal fascia at M. rectus abdominis. These branches contain parietal peritoneal nerve fibers. A nerve bundle of them was severed at a point in the layer of M. transversus abdominis and the muscle branches which arose from the distal segment were cut off remaining subperitoneal branches. The peripheral nerve segment freed from the muscle branches were teased into the threads at the cut end of the nerve. The cut end of each thread was hanged one by one in search of a fiber responding to the stimulants applied on the parietal peritoneum. A microscopic technique was used for the above

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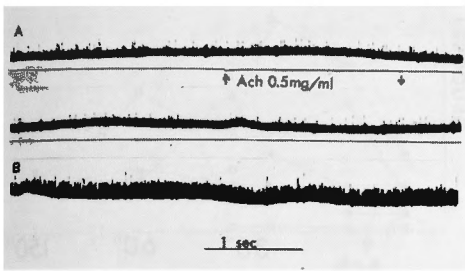


Fig. 2. Afferent impulses in the parietal peritoneal nerve with application of Ach. (0.5mg/ml) to the parietal peritoneal surface. A. In the second row the continued recording from the upper is shown. B. Responses several minutes after application of Ach.

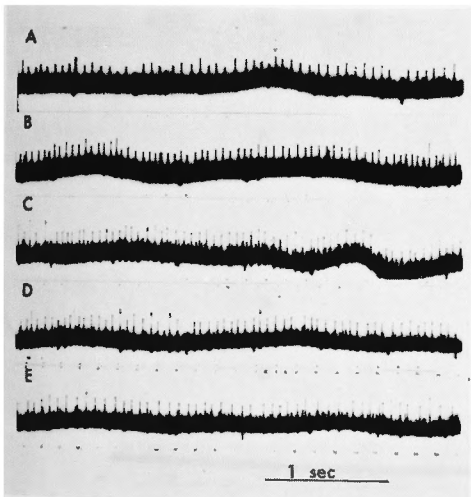


Fig. 3. Response of a functional single fiber of the afferent parietal peritoneal nerve to application of Ach. (0.2 mg/ml) to the parietal peritoneal surface.

A : before application B : 5 seconds after application C : 25 seconds after D : 35 seconds after E : 1 minute after

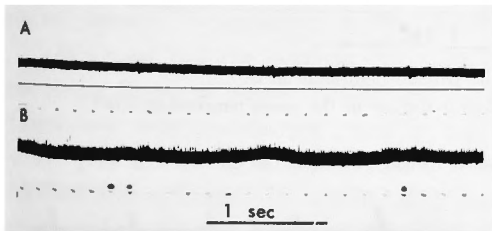


Fig. 4. Afferent impulses in the parietal peritoneal nerve after application of 10% NaCl solution to the parietal peritoneal surface.

A : immediately after application
B : several minutes after

preparation of the nerve.

A piece of filter paper immersed in a stimulant was taken out and was put on the rectus abdominis portion of the peritoneal surface for applying the stimulants on the parietal peritoneum.

2) The right phrenic nerve of the cat anesthetized with nembutal was used. The nerve was cut at the neck or in the thorax, the peripheral segment of which was prepared microscopically to get a relatively functional single fiber. Stimulation was given to the abdominal surface of the diaphragm with a finger touch, or to the gallbladder by artificial dilatation of the wall with a balloon. Conduction velocity of the afferents was measured by synchronous recording of the action potentials in a pair electrode (distance : 2 mm).

3) Action potentials of the nerves were amplified with a C-R amplifier and recorded on an oscilloscope.

Experimental results

1) Responses of the parietal peritoneal afferents to application of acetylcholine (Fig. 2, 3), 10% NaCl solution (Fig. 4, 5) and etc. on the parietal peritoneal surface were recorded.

2) Responses of them have long latencies. Fig. 6 shows the relation between discharge frequencies (illustrated as 'response' in Fig. 6) and the lapse of time after the application of acetylcholine (Ach).

3) Intensity of the responses did not depend on the kind of stimulants (cat's bile, HCl solution, 10% NaCl and 0.1% NaCl solution). Fig. 7 shows intensities of the responses to the various stimulants applied on the parietal peritoneal surface. Intensity of the response in Fig. 7 is indicated with ratio of frequency at the maximum after stimulation, to the spontaneous discharge frequency.

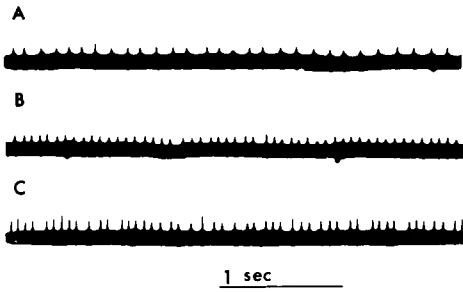


Fig. 5. Response of a functional single fiber of the afferent parietal peritoneal nerve to application of 10% NaCl solution
A : 1 minute after application
B : 2 minutes after C : 3 minutes after

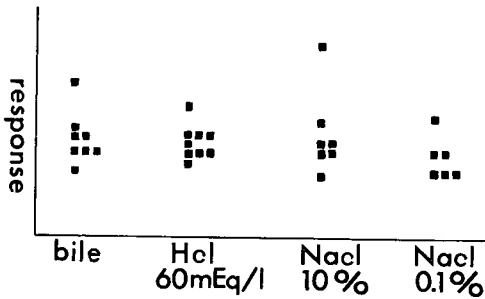


Fig. 7. Intensity of responses in single fibers of the parietal peritoneal nerve to the application of the various stimulants to the parietal peritoneal surface.

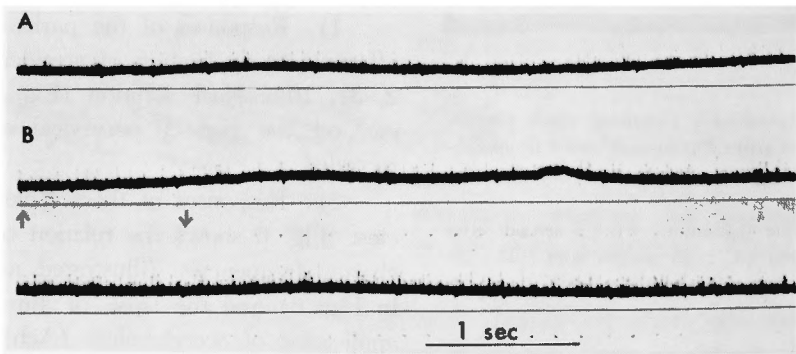


Fig. 8. Afferent impulses in the parietal peritoneal nerve
A : after 30 minutes exposure of the parietal peritoneal surface in the room temperature (18°C)
B : the lower is continued from the upper.
^ : dashing the parietal peritoneal surface with warm Ringer's solution (40°C)

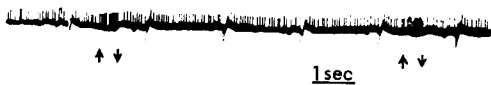


Fig. 9. Afferent impulses in the right phrenic nerve with finger touches to the diaphragm.
^ : during a finger touch.

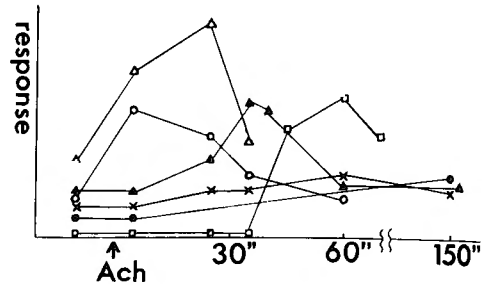


Fig. 6. Relation between discharge frequencies of the parietal peritoneal nerves and the lapse of time after the application of Ach. (2 mg/ml) to the parietal peritoneal surface.



Fig. 10. Afferent impulses in the right phrenic nerve during the artificial dilatation of the gall bladder.
Pr. : internal pressure of a balloon in the gall bladder.

As to the fibers without spontaneous discharge, frequency of a unit discharge at the maximum after stimulation is used.

4) Increase in discharges from the peritoneal afferents was observed about 5 seconds after dashing with warm Ringer's solution to the peritoneal surface which had long been exposed to the room temperature. (Fig. 8).

5) As to the phrenic nerve fibers responding to finger touch on the diaphragm (Fig. 9) and to artificial dilatation of the gallbladder with balloon (Fig. 10), conduction velocity of them were the same calculating about 5 m/sec. Concerning the abdominal parietal peritoneum the conduction velocity of the fibers responding to a finger touch on the surface was calculated about 20 m/sec, and that of the fiber responding to application of 10% NaCl solution was slower.

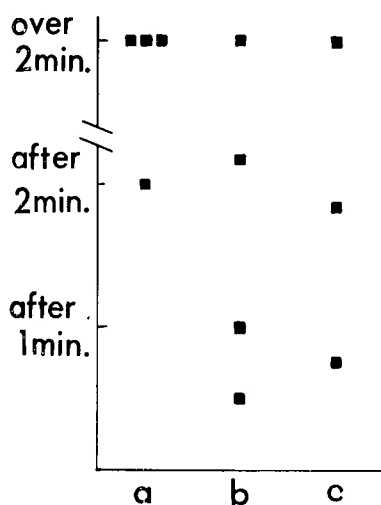


Fig. 11. The time required for appearance of painful complaints after application of the various stimulants to the peritoneal surface.

- a : Ach 1 mg/l in 0.80% NaCl solution
 b : Ach 1 mg/l in 10% NaCl solution
 c : Ach 1 mg/l in pure water

Clinical experiment

Pain of the parietal peritoneum was observed in the patients of appendectomies under local anaesthesia. The abdominal wall was elevated at the wound with a hook cautiously so as not to be painful.

The stimulants (acetylcholine in 0.85%, 10% NaCl solution and in pure water) were applied to the peritoneal surface at the portion of M. rectus abdominis on the left side under every precaution to protect viscera from stimulation.

Latencies of uncomfortable complaints were measured (Fig. 11). The uncomfortable complaints were of various natures usually with some kinds of pain.

Comments

1) Sensation of the parietal peritoneum arising from the diaphragmatic portion is conducted through the afferents in the phrenic nerve.

We have had the concept that abdominovisceral sensation in general was carried on the nerve fibers of slowly conducting velocity. It is shown that the phrenic afferent nerve fibers have slow conduction velocity and carry the visceral sensation of the gallbladder when it is artificially dilated, while they carry the diaphragmatic sensation when it is touched with a finger. Clinically, pain from the gallbladder projects in the right shoulder and subdiaphragmatic sensation gives no exact local sign. So it seems that the afferents of slowly conducting velocity, even if they are contained in a somatic nerve, carry a sensation with visceral character or with visceral pain.

2) Most clinicians believe that the parietal peritoneum is sensitive. However, the parietal peritoneum consists of a simple epithelium, subepithelial connective tissue and the

transversal fascia, and there are no nerve endings in the epithelial layer (Fig. 1). CAPPS and COLEMAN pointed out that mechanosensitivity was in the subepithelial tissue and we found chemosensitivity in the subepithelial tissue, too. It is the proof that long latency of responses to application of the stimulant demonstrates that the time is required for the stimulant to pass through the epithelium and to arrive at the nerve endings.

Mechanoreceptor may be stimulated with Ach, but it is not proved that 10% NaCl and etc. stimulate the mechanoreceptor. So we consider that the responses observed here initiate from chemoreceptors.

These responses have long latencies with divergent values. It indicates that resistance of an epithelial layer against passage of the stimulants may vary with the conditions of the experiments. Clinical responses to acetylcholine in hyper or hypotonic solution tend to appear earlier than in a normotonic solution. These results also suggest a resistance of the epithelium against passage of the stimulants and deterioration of the resistance caused by hyper- or hypotonic solution.

We cannot explain well on the result shown in Fig. 8, but this suggests complexity of peritoneal sensation.

It was said that pressing, massage or other mechanical stimulations except pricking to the peritoneal surface caused no pain. The above mentioned clinical observation, however, pointed out that pressing or massage of the parietal peritoneum produced painful complaints with complicated and various kinds of expression. Application of acetylcholine in various solution also produce uncomfortable sensation like pain: traction, irritable, pricking sensation and etc. successively appear with various combinations according to the cases. Diversity of latencies of the responses, variety of the complaints and miscellaneous combination of them seem to depend on the fact that many kinds of receptors of peritoneal sensation are scattered in the subepithelial tissue, the fascia and sometimes in the muscle. And these receptors can more or less be responsible for pain sensation of the peritoneum.

3) Concerning perforation peritonitis, it is said that stomach cases are more painful than the cases of the gallbladder. Intensity of responses of the parietal peritoneum to the stimulants did not differ from each other according to the kind of the stimulants (bile, dil HCl, 10% NaCl and 0.1% NaCl).

However, this results cannot deny the clinical impression that intensity of pain in the stomach case differs from that of the gallbladder. Considering of retroperitoneal and visceral sensation possibly participating in pain of perforation peritonitis and of pain producing substances (in PH, concentration and etc.), further studies are needed.

Summary

1) As to the afferent discharges in the abdominal somatic nerves of the cats, responses to the chemical stimulants applied on the parietal peritoneal surface were observed. Diversed long latencies of responses to the stimulation and no difference from intensity of responses to the various stimulants were shown.

2) Conduction velocity of the cat's phrenic nerve fiber responding to dilatation of the gallbladder and a finger touch on the abdominal diaphragm was measured (both,

about 5 m/sec). That of the abdominal parietal peritoneum was also measured (20m/sec, in case of a touch on the peritoneal surface: more slowly in application of the stimulants).

3) Painful complaints against chemical stimulation of the parietal peritoneum were observed in clinical materials. Diversed but painful complaints with long latencies suggested the complicated character of peripheral sensation of the parietal peritoneum.

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和文抄録

体壁腹膜の知覚に関する若干の生理学的知見

京都大学医学部外科第二講座 (指導: 木村忠司教授)

町 塚 昭, 恒 川 謙 吾, 古 川 浩, 熊 田 馨

1) 猫の腹壁求心性神経について体壁腹膜に化学的刺激を加えた場合の放電を観察した。

この神経にあらわれる腹膜刺激後の反応は常に潜時が大で、しかもその値は多様である。また反応の強さは、刺激の種類 (胆汁, 希塩酸, 高稠食塩水, 低稠食塩水) によって差違を示さない。

2) 猫の横隔膜神経について、胆嚢の拡張及び腹腔側から横隔膜膜様部を指で触れることによって求心性に興奮する神経線維の伝導速度を概算して毎秒 5 m の

値を得た。体壁腹膜からの求心性神経については、体壁腹膜に指で触れた場合に興奮する線維の伝導速度は約毎秒 20 m の値を得たが、化学的刺激の場合には伝導速度はより緩徐であつた。

3) 体壁腹膜の化学的刺激に対する反応を臨床材料によつて観察した。刺激によつて「いたみ」が訴えられるが、この反応の潜時は長くその値は多様でありしかもその表現は多岐にわたつていて、体壁腹膜の末梢知覚の複雑さうかがわれた。